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REPORT

TO THE TRUSTEES

OF

LAKE SUPERIOR COPPER COMPANY.

BY

CHARLES T. JACKSON, M. D.

1845.

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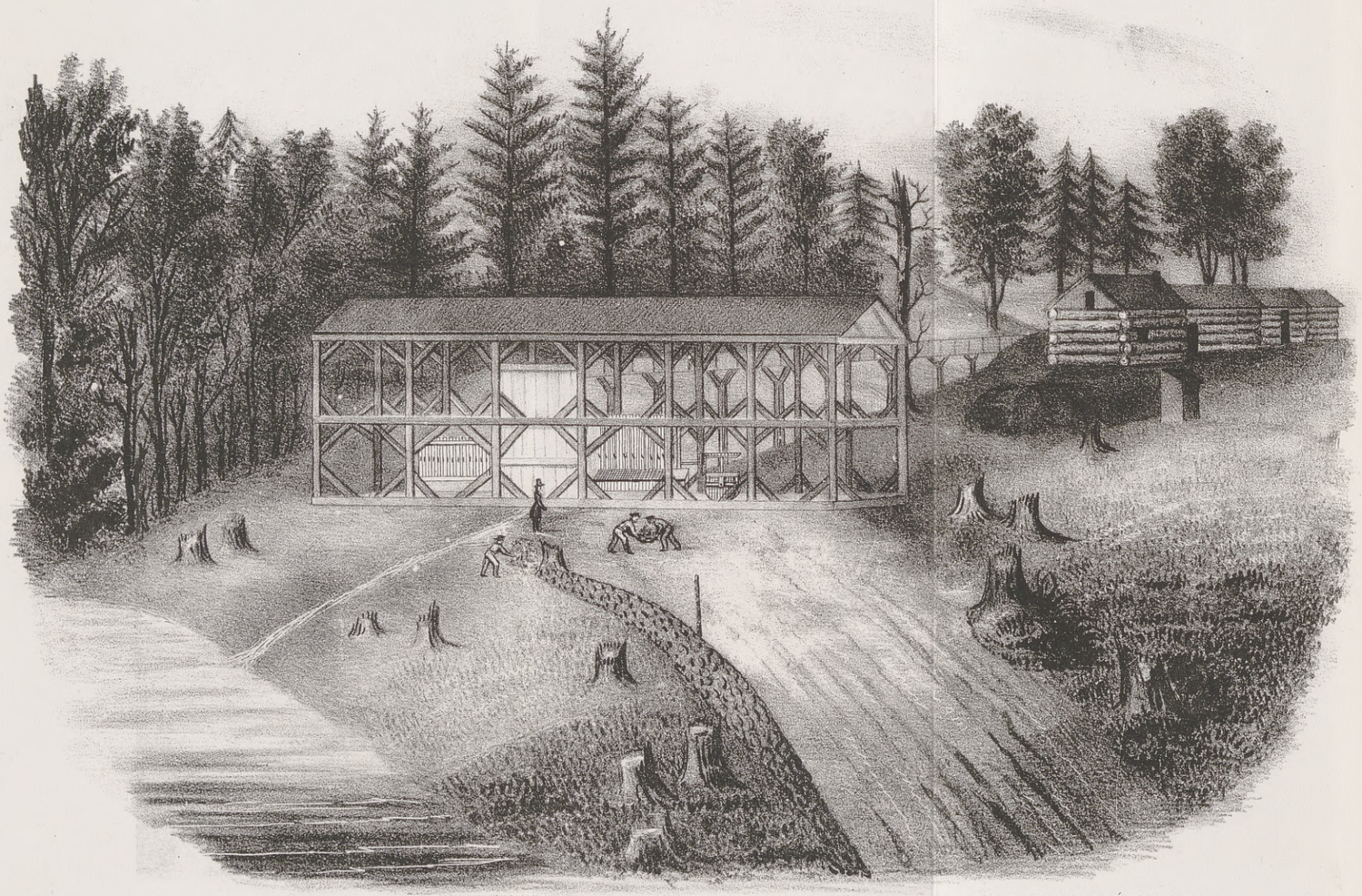

C.T.JACKSON, DEL.

LITH. OF E.W.BOUVÉ, BOSTON.

VIEW OF THE STAMPING MILLS.

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DR. CHARLES T. JACKSON'S

REPORT

TO THE TRUSTEES

OF

LAKE SUPERIOR COPPER COMPANY.

NOVEMBER, 1845.

BOSTON:
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1845.

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REPORT.

Boston, Nov. 1st, 1845.

To the Trustees of Lake Superior Copper Company:

Gentlemen—At the request of your Board I spent the past summer in re-examination and continued survey of the copper and silver veins on Eagle River, and have directed the mining operations and the erection of the machinery required for separation of the metals from the rock. I have analyzed and assayed a great number of samples of the ores from the mines now wrought, and from those which have been recently discovered and are not yet opened by mining operations. Whatever labors may be still required for your information I shall be ready to perform, and hope soon to complete the work.

While at Eagle River it was impossible for me to perform many complete analyses, since I had there but few conveniences for chemical operations, and but a limited supply of tests and reagents. Much of the mechanical preparation of the ores was there effected, so as to diminish the quantity of matter I should have to bring home with me. I could there stamp and wash the ore, and pack up the cleansed metals, which were to be separated in my laboratory, after my return to Boston. A large supply of samples obtained from given weights of ore were thus prepared, and are now ready for assay and analysis. The specimens were taken from all parts of the mine as the work proceeded, and fairly represent the working value of the ore.

On reaching Eagle River early in July last, we found the mining operations had been suspended, there being but few miners on the ground, since their term of service had expired, and many had gone

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home. The 75 foot shaft was nearly full of water, and the curb was out of order, so that operations could not be carried on immediately. This shaft was put in good order and the water was drawn out, while I was there, and an opportunity was afforded to inspect that portion of the mine. It was obvious that the rock in which that shaft is sunk is not a part of the vein, but is wall rock impregnated with numerous globules of copper, and traversed by small string veins of metallic copper. It is out of the course of the vein some degrees to the Eastward, and is in the rock which I described last year as the "wall rock containing copper, 94 feet North of the main lode or vein." From the bottom of this 75 foot shaft, a drift had been sent off to the Westward 13 feet, but had not reached the vein. It will have to be carried about six feet farther West before it strikes it, for the lode in the 30 foot shaft runs, as is proved by the 16 foot drift, N. 32° W., while the shaft bears from the other N. 21° W., and the distance is 93 feet, giving a departure of 20 feet to the Westward as the place of the vein. The ore thrown out of this 75 foot shaft is poor, but rich enough to repay the expenses of stamping and washing it with a small profit; but it will not be worth mining, and I therefore advised that the shaft should not be sunk any deeper, but that the cross cut should be extended until it came to the vein, and that a drift should be sent from it to the second or 30 foot shaft, which will be sunk to the depth required to meet that drift while the work is going on in it.

I did not advise sinking the 75 foot or first shaft last year, and suppose the miners saw some indications there which induced them to operate in that place before sinking the second, or 30 foot shaft, which I had recommended. It would have been a more profitable work had my directions been followed exactly; for the labor spent on the 75 foot shaft would have carried the 30 foot shaft to the depth of more than 100 feet, and levels could have been sent off from two points on each side of the shaft, at 50 and 100 feet depth, running up and down the river's course along the vein, whereby a much greater number of miners could have been employed, and richer ores would have been raised in large quantities.

I regard the 75 foot shaft as a valuable means of ventilation, and it will be made the air shaft of the mine in future work, while the second shaft will be the main or working shaft. A plan of the workings ought to be kept, and it may be well to draw a guide plan for the direction of the miners, which will serve as a diagram which

they can follow so far as the nature of the rock and the situation of the ore allow.

The second, called also the 30 foot shaft, was made at the point indicated by me last year as the proper place for the main shaft. It is on the cliff beneath which we obtained our samples of copper and silver last year. The cliff is fifteen feet high from the water of the river, and the vein is seen in its wall from top to bottom, and is eleven feet wide on the face of the cliff—six feet of the vein contains silver, and five feet of it is charged mostly with copper, a few globules of silver being occasionally intermingled with the rock. The surface of the vein exposed to the action of air and water has become disintegrated, and the copper is mostly incrusted with the green carbonate and red oxide, while the globules of silver, varying in size from a pin's head to that of a small bird shot, are thickly implanted in the rotten rock, and retain their brilliancy. Particles of antimonial silver in thin and brilliant spangles are intermixed with this portion of the vein, and add to the proportion of silver, so that the ore yields more than any one would suppose from its appearance. The most curious phenomenon presented by this ore is the occurrence of pieces of pure silver united to metallic copper without any other union than at their points of contact, where there is as close a joining as could be effected by plating, and without the interfusion which takes place in the artificial operation. The copper sometimes contains alloyed with it a very small portion (3-10 per cent.) of silver, but the silver never contains the slightest trace of copper. Hence I suppose the silver was thrown off from an original alloy of copper and silver in the operation of cooling, by the segregation of the silver from the copper.

Some portions of the above described rotten rock are very rich in silver, and one sample assayed by me yielded copper and silver in the ratio of $1200 per ton, while the general average of the undecomposed rock gave but from 125 to $129 per ton. It is not to be supposed that a large proportion of the vein will yield so large a per centage of silver; but the above example will show how very rich some parts of the vein are.

Where the shaft cuts through the rotten rock, there is no green carbonate of copper, but the red oxide of that metal is abundant, and colors the rock red. I was much surprised by the richness of that kind of ore, for on analysis I found it to yield in value equal to

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$748 per ton—its principal value consisting in the silver which it contains in fine globules abundantly diffused through its mass.

The general character of the lode of the second shaft is not so good as above mentioned, for the shaft cuts through both copper and silver rocks and sometimes through comparatively poor ore and occasional barren seams of hard trap rock. The slope of the vein of silver ore carries it on one side of the shaft as it goes down, and hence you will have to make a cross cut to meet it again at a considerable depth. It is seen on the Eastern side of the shaft throughout its depth from the surface to 25 feet from the top; then the vein goes out of the shaft to the Eastward.

When I arrived at Eagle River, this shaft was 25 feet deep, and its walls were left rough and jagged. Miners were set at work, and it was squared down evenly, ten feet in length by eight feet in width, and a level was driven in from the bottom after sinking the shaft five feet more. This level was intended to show the richness of the ore towards the Northwest, and ran N. 32° W. in very rich ore. It was discontinued after having been driven 16 feet, since it was evidently too near the surface to drift economically. It served to prove the richness of the ore, and the direction of the lode. A new gang of miners having been hired, we were desirous of ascertaining how rapidly the shaft could be sunk by them; and having measured its depth, we set a gang at work in a regular manner, and found that they sunk six inches per day on a bottom of 80 square feet area—hence raised 40 cubic feet of ore per day. On the drift or 16 foot level, with a head of 30 square feet, a less efficient corps of miners progressed at the rate of six inches per day, or 15 cubic feet; but they were delayed for want of tools, and by foul air, so that no just estimate on drifting could be obtained by their work. As a general rule, about one-third more rock may be excavated by drifting than can be raised from the shaft in the same given time. The cost per foot on the shaft will be not far from $20, allowing 40 cubic feet of ore to be raised per day. Each cubic foot will weigh from 193 to 200 lbs.; hence four tons of ore will be raised per day, at a cost of $20 for mining. It is proposed that the work should be let out to the miners at the rate of $20 per foot in the shaft, and they will make their profit by working extra hours and by doing their own windlasing, which usually requires an extra laborer.

When I left the mines, the second shaft had been sunk to the

depth of thirty-seven feet, and was eight feet by ten feet square. Rich ore was still obtained from the bottom of it, and copper was seen on every side. There are lines of separation between the silver and copper lode and the wall rock, which indicate a dip in the vein of 80° North Eastward. Should this prove to be the true dip of the vein, the width of the whole lode being 11 feet, it should run out of the perpendicular shaft to the North Eastward at the depth of 32 feet, as will be seen by the diagram in my sketch book, which I send with this Report for your inspection. (See Pl. 10.) The ore, as before observed, occurs at the depth of 37 feet in the shaft; hence it is obvious that the vein is wider than I had supposed from the appearance of it in the cliff at the surface, or the dip is greater than was anticipated. If there is any dip or inclination from the perpendicular in the descent of the lode, which is usually the case in mines, it is evident that the shaft will ultimately leave the vein, and then you will have to make a cross cut back to it. I mention this very obvious fact, since inexperienced persons might be alarmed by the idea that the ore runs out, when the shaft happens to leave the vein.

The following are the points where the ore is exposed by your mining operations, in the regular course of the vein, beginning at the Northernmost opening. (See plan, Plate 1.)

1st. The adit level, made by my direction. This will be 93 feet in length to the 75 foot shaft, and will be met by a cross cut from that shaft. In this level the ore was poor at first, and becomes richer as the work advances to the South Eastward. The adit at its mouth is 28 feet below the top of the 75 foot or first shaft, and is nearly on a level with the 16 foot drift in the second shaft, with which it will ultimately join.

2d. The 75 foot or first shaft, which is irregularly wrought, and will not be necessary to square down, since it will serve for an air shaft and need not be made so exact as the working shaft. The ore raised in this work is poor, but worth stamping for copper.

3d. The second or 30 foot shaft. This is now the main shaft of the mine, and is wholly in the richest ore. It is opened on ground five feet higher than the first shaft.

4th. The vein crosses the stream to a point projecting into the river, (see 4 on plan), and there another shaft has just been commenced, which will ultimately be connected with the second shaft

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by levels under the river at 50 feet below the top of the shaft, or 35 feet below the river's bed.

5th. The shaft at the upper end of the vein, where it branches and sends a walled vein through the felspar and chlorite rock which leaves the river's bed and runs across the line of the canal, while another branch runs up the channel of the river and is exposed to view in amygdaloidal trap rocks. The shaft sunk is 20 feet deep, and is an exploration work now abandoned, as the vein was too narrow there to repay expenses of mining, and the rocks were very hard.

The stamping and crushing mills, with the joggling tables, settling troughs, &c., were put up by Mr. C. C. Douglass, who received his directions from me. The plans were selected from the French works on mining, and a combination of machinery adapted to the working of the Eagle River ores was made, and has been constructed and put up by Mr. Cowey, under the superintendence of Mr. Douglass, who has effected the work in a satisfactory manner.

The mill is 65 feet long on the lower story, and 25 feet wide, while the upper story is 90 feet long, and rests on the bank. (See plan, Plate 3.)

The water wheel is 15 feet in diameter and 10 feet wide, and is on the overshot plan; the buckets are 15 by 10 inches. A double battery of stamps on one side of this wheel consists of 24 pestles, of 200 lbs. weight each, striking on a thick iron trough or stamping bed. Each pestle lifts by a cam, and falls 12 inches. They drop in regular succession, one battery pounding the ore forwards and the other backwards, (see Plate 5) while a current of water is allowed to pass through and washes away first the fine rock, and then the coarse metal is driven forward by a more powerful current. The metals are then separated by joggling tables and other apparatus prepared for the purpose.

On the other side of the water wheel a combination of stamps and the crushing mill is placed—the battery of stamps being nine pestles, and the crushing wheels weighing 5000 lbs. each. This machine works very satisfactorily, and will be employed in crushing the silver ore. (See Plate 6.) Some improvements were made in it, and the water is to be brought directly to the crushing bed, to wash out the metals more readily. The receiving trough will contain most of the coarse metal, and the fine will be sent over on the

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sleeping tables where it will be deposited. The coarse metals will be cleansed entirely from rock on the joggling tables, and will be ready to pack up and forward to market.

The washing apparatus was not completed when I left the works, and hence I could not have a large quantity of ore wrought under my immediate superintendence; but I was able to stamp and wash two thousand pounds of the ore, by using hand jigs or sieves of copper wire. The fine ore was left, while the coarse metals were packed up and brought home for analysis. The results of my researches on those metals are appended to this Report.

The plan in my sketch book, Plate 1, will show the situations of the shafts. The whole known length of the vein is about 1800 feet. Its width is satisfactorily proved to be 11 feet for the distance of 200 feet, and it is probable that it will hold a workable width throughout the whole 1800 feet.

It is obvious, that there is an adequate quantity of rich ore in this vein to render the work very profitable, and that there is no danger of exhausting the ore even should it give out at the depth of 100 feet, of which there is no probability.

Native copper, I know, is not usually found in great quantities. In Europe and in Cuba the ore is apt to change into sulphuret of copper and iron after attaining a considerable depth—but in those cases there are sufficient proofs of the secondary origin of the copper from decomposed copper pyrites, while the absence of sulphurets and the want of iron ochre both indicate the permanency of the metallic copper in your mines. I cannot see any reason to believe that there will be any change in the ores so long as there is no change in the character of the rocks in which they occur.

Some persons object to the Lake Superior mine because the vein has no regular walls; but this seems to me to be a matter of little consequence so long as we can see that there is an almost inexhaustible supply of metals in a linear direction sufficiently compacted to be worked profitably. How can there be regular walls to a vein when it is of the same age and origin as the trap rocks in which it is included?

Where the vein runs through the more ancient felspar and chlorite rock at its South Eastern end, there it is most certainly walled by that rock, and the course of the vein coincides with that of the metalliferous lode wrought at the shafts Nos. 1, 2 and 3. If

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the ore runs out at a considerable depth, say at 200 feet, it will be a matter of little importance to the present generation, though it might be to posterity: for there is obviously an adequate supply of ore to occupy your miners for a great number of years in extracting it. So far as your operations have extended, they have added to the value of the location by the discovery of several new veins. Thus the Third Falls vein has been discovered since the works began; and in making a road from the mines to the mill, and in digging the mill pond, and in laying the foundations of the stamping mill, a new vein of copper and silver of great richness was discovered. It is probable that other new veins will be discovered from time to time, as improvements continue to be made, and the wilderness is cleared up, and the soil opened to the rocks.

The Third Falls vein pursues a course nearly parallel with the vein you have been working, and promises to be valuable. The average ore gives about 9 per cent. of a mixture of metallic copper and silver. Its width could not be ascertained, since the vein is only exposed in the bed of the stream. This vein is a continuation of that at the second falls, discovered last autumn by Mr. Joshua Childes—and our attention was called to its occurrence at the third falls by Mr. Foster, of Ohio, who visited the mines this summer.

The new vein at the stamping mills was discovered while blasting away the rocks for a foundation of the upper story of the building, where it projects over on the cliff. It is a vein of Prehnite, filled mostly with metallic, green carbonate and red oxide of copper, but in some places it was exceedingly rich in metallic silver. This vein is from 3 to 5 inches wide, and has been seen in four places: 1st, in the bottom of the root house; 2d, in the road to the mines; 3d, in the mill pond dug this year; 4th, in the foundations of the mills. These points are all in a line N. 11° W., S. 11° E., and the dip of the vein is 79° to the Westward.

Where the vein was opened, the course was N. 19½° W., S. 19½° E., which is the true course of the horizontal line of the vein—the course of the openings differing on account of the difference of level and the dip of the vein.

I have given directions to have a shaft sunk in the vicinity of the mill, and I marked its place on the ground, so that it will strike the vein. A drift will then be sent off towards the place where we found the richest silver ore; and it may be wrought without damaging the mill, since a sufficient roof may be left to

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support it, while the ore will be taken out below. This vein is a lateral or string vein, called by the miners a feeder, from the principal lode, and is regularly walled.

It is narrow, and will not repay expenses of working unless it contains silver generally in its mass, or unless the wall rock contains copper, for the drifts will have to be made at least four feet wide to allow the miners room to work. The shaft sunk upon it will at present be merely one of exploration, and the result will decide as to future work at that place.

Ore as rich as that taken from beneath the mill would give an enormous profit, for there are few silver ores in the world equal in richness to the specimen I obtained there. It should, however, be stated that the other parts of the vein exposed to view contained only native copper and its ores; hence we ought not to form too sanguine expectations from the few specimens extracted thus far from this vein.

CHEMICAL ANALYSES OF THE ORES.

Analysis of the red rotten rock, (red oxide of copper, metallic copper and silver, in amygdaloidal trap rock.) The rock was suitable for analysis in small portions, being very uniform. The

pounded ore weighed - - - - - -	749·5 grains.
Lumps of copper and silver separated by stamping,	175 grains.
Fine sifted rock and ore, - - - - -	574·5 grains.

50 grains of the last mentioned ore yielded 11·3 grains of red oxide of copper, 3 grains of metallic copper and silver, and 35 grains of rock. The red oxide of copper is 22·6 per cent., and the metallic copper 6 per cent. in the fine ore.

100 grains of another portion of the same powdered ore gave, by analysis by acids, 21·5 grains of copper and silver. The silver amounted to 0·05 grain. Antimony was detected in the solution after the silver was separated.

20 grains, an average of the copper and silver analyzed, yielded 0·4 grs. chloride of silver, or 0.3 of metallic silver, or 1·5 per cent.

Hence the yield of 100 lbs. of the red rotten rock will be 40 per cent. of metals, and the silver in the copper will be 1.55 per cent.

40 lbs. of copper is worth, at 16 cts per lb.,	$6 40
1·55 lbs. of silver, at $20 per lb.,	31 00
Value of 100 lbs. of the ore,	$37 40

or $748 per ton.

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A sample of the rock from the silver vein was taken from the broken ore in a shovel by one of the trustees of the Company; and the whole shovel full being pounded, weighed, washed and analyzed, yielded per ton as follows:

Copper from the coarse washings,	42·86 lbs, worth at 16c,	$7 65
Silver, - - - -	5·87 lbs, worth at $20,	117 54
Value of one ton of the rock, - -		$125 19

In this analysis, a little metal was lost in fine waste, and therefore, although the rock was the same as I analyzed last year, with the result of $129 35 per ton, it yielded less than it did in a well arranged laboratory. The result was, however, quite satisfactory to the trustees, and confirmed the fairness of my analyses of the ore obtained at my first visit. The vein from which the ore was taken is 6 feet wide; and the specimens were blasted off from the whole face of the vein last year by my direction, and were broken small for the crushing mill, and piled up at the base of the cliff.

It should also be stated, that from that rock most of the rich specimens of silver have been obtained that have been brought away from the mine, selections having been made while the ore was undergoing the breaking under the hammer.

Analysis of the rotten rock, on the face of the cliff, at the second shaft:

9 lbs. of the rotten rock being pounded in a mortar, and washed with care, gave - - 230 grains coarse metals,
3230 grains of fine metals;

3460 grains of copper and silver mixed.

The copper separated amounted to	3344·25 =	106·12 lbs	$16 99
Silver " " "	65·75 =	2·08 lbs	41 60
Antimony-traces, not weighed.		Per ton of rock,	$58 59
Rock separated from the metals,	50·00		

3460·00 grains of washed ore.

Rock of the silver vein taken from the base of the cliff at the second shaft:

3 lbs. 2 oz. of the ore, pounded and washed, gave 1338 grains; of which the

Per ton of rock.

Copper weighed	1239·98 grains	113·4 lbs. at 16 cts.		$18 14
Silver "	6·02 "	0·546 lbs. at $20 per lb.		$10 92
Rock "	92·00 "			
		Value of one ton of rock,		$29 06

1338·00 grains coarse washings.

Fine washings from the same—809 grains yielded—

On a ton of rock.

Copper,	418·73 grains =	38·29 lbs.	value at 16 cts.	$6 12
Silver,	5·27	·482 lbs.	" " $20	$9 64
Rock,	385·00			

809·00 grains washed ore.

$15 76 per ton of fine washings of the rock.

Analysis of rich silver ore (rotten rock:)

1 1-2 lbs. yielded, after being pounded and washed, 592 grains, of which the

Per ton.

Copper weighed	381·40	72·6 lbs. at 16 cts.	$11 62
Silver,	25.60	4·87 lbs. at $20,	$97 40
Rock,	185·00		
		Value of rock per ton,	$109 02

Washed ore, 592·00 grains.

From the same, 5760 grains waste was obtained, of which the

Copper weighed	715·49 grains =	136·28 lbs. at 16 cts.		21 80
Silver, "	4·51 "	0·858 lbs. at $20,		17 16
Rock, "	5040.00 "			
		Value of the waste on one ton the rock,		38·96

5760·00 grains.

Another lot of the same rock, weighing 8 lbs., gave 2540 grains large pieces of copper, and 4500 grains of metals and rock; of which the

Copper weighed	2134·15 =	76.22 per ton of rock, at 16 cts.,	$12 19½
Silver "	57·85 =	2·06 lbs. per ton on the rock, at $20,	$41 20
Rock "	2308·00		
		Value of one ton of rock,	$53 39½

4500·00 grains.

Fine copper,	2134·15
Copper in large pieces,	2540·00

4674·15 grains—whole weight of copper.

Another sample, weighing 3½ lbs., yielded 2741 grains of metals and rock:

Copper,	2253·4 grains	184 lbs. at 16 cts.,		$29 44
Silver,	37.6 "	3·07 lbs. at $20,		$61 40
Rock,	450·0 "			
		$90 84 value of 1 ton of the rock.		

Washed ore, 2741.0 grains.

From the same lot, 3900 grains fine washed ore was obtained, in which the

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			Per ton.	
Copper weighed	788·8 grains.	404·5 lbs at 16 cts.,	value	$64 76
Silver "	11·2 "	5.74 lbs at $20,	-	114 80
Rock "	3100·0 "			
	3900·0 grains.			$179 56 value 1 ton of rock.

Another lot, weighing 1 lb., stamped and washed, gave 594 grains metals and rock, of which the

		On the rock.	
Copper weighed	521·15 grains.	148·9 lbs at 16 cts.,	$23 82
Silver,	12·05 "	3·44 lbs at $20,	68·80
Rock,	60·80 "		
	594·00 grains.		$92 62 value of one ton of rock.

The waste washings from the same weighed 2880 grains, of which the

Copper weighed	454·58 grains.	115·5 lbs at 16 cts.,	18·48
Silver "	5·42 "	1·548 lbs at $20,	30·96
Rock "	2420·00 "		
	2880·00		$49 44 value per ton of rock.

A fair specimen from the bottom of the 37 foot shaft yielded 80 lbs. copper in 1000 lbs. of the ore. It was from the copper vein, and free from any admixture of silver, excepting a few minute grains.

Analysis of the ore from the newly discovered vein at the third falls of Eagle River, one-quarter of a mile north of the shaft before described:

11,170 grains of the rock, reduced to powder in an iron mortar and sifted, left coarse metals on the seive weighing 830 grains, of which,

Copper,	823·00 grains.	147·3 lbs at 16 cts.,	$23 56
Silver,	3·01 "	0·54 lbs at $20,	10 80
Rock,	4·00 "		
	830·01		$34 36 value of one ton of rock.

The remaining sifted powder washed, gave 210 grains of metals and rock, viz:

Copper,	155·875 grains	= 19 lbs per ton of rock,		$3 04
Silver,	1·125 "	= 0·19 lbs per ton of rock,		3 80
Rock,	53·000 "			
	210·000			$6 84 value of one ton of rock.

The ore yields 9·31 per cent. of waste metals, as above. Value, $41 20 per ton of rock.

When the stamping and crushing mills were ready for operations, I first set them at work on an average lot of the ore from the mines, without employing weighed quantities, as we had no means

of separating the metals from the stamped and crushed ore at that time. Subsequently, we prepared copper sieves, and separated samples of the metals by the operation of jigging; and I have brought home with me two shot bags of the metals, as specimens of the work performed by the mill.

Subsequently, I endeavoured to ascertain how much work the mills would do per day; and at the same time I worked on 1000 lbs. of the rotten rock, and on 1000 lbs. of the solid ore of the silver vein before described. I found that the mills would stamp about 6 tons of the ore in 24 hours; and it is probable that with a more ample supply of water, and with more experience in the workmen, the quantity may be raised to 8 or even 10 tons.

1000 lbs. of the rotten rock, on being stamped and washed by the mill, and jigged in sieves and separated by the strake and keive, gave, in a coarse way, 105 lbs. of clean metals, viz:

3 lbs. of large pieces of copper and silver;
7 lbs. of fine jigged metals;
95 lbs. of fine metals from the keive;

105 lbs. metals per 1000 lbs. of rock.

Besides this, there was a large waste for want of joggling and sleeping tables for the washing operations.

I brought home with me the 3 lbs. of the coarse and 7 lbs. of fine washed metals and samples of a few pounds' weight of the fine metal of the keive and of the waste of each kind.

Analysis of a sample of the coarse metals from the rotten rock, separated by the stamping and crushing mills, and washed by the jigs:

1000 grains coarse metals analyzed, yielded
950 " of copper and silver,
50 " of rock.

The copper and silver separated, yielded—

Copper,	927 grains	=	1854 lbs. per ton—value,	$296 64
Silver,	23 "	=	46 lbs. per ton—value,	920 00
				$1216 64

1000 grains of the fine metal of the 7 lb. lot from the jig yielded
925 grains copper and silver, and
75 grains of rock.
Separated, the

Copper weighed	904 grs.	=	1808 lbs. per ton—value,	$289 28
Silver	21 grs.	=	42 lbs. per ton—value,	840 00
			Value per ton, - - - -	$1129 28

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Fine washed metals from the keive:

Per thousand or per ton.

1000 grains yield—Copper, 964·5 grains—value, $154 32—$308 64
Rock, 35.5

1000·0 grains.

Traces of silver not sufficient to be valuable.

Analysis of the average metals of second shaft:

Copper,	957·8 grains =	1915·6 lbs. per ton—value, -	$206 49
Silver,	6·7 grains =	13·4 lbs. per ton—value, -	268 00
964·5 grains.		Value of 1 ton of average metals from the ore heap at 2d shaft,	$474 49

Analysis of the ore of the first shaft, which is the wall rock of the vein—the shaft being to the eastward of the lode:

4500 grains, stamped and washed, gave 130 grains of copper and rock:

Copper,	44·24 =	19·66 lbs. per ton—value,	$3 11
Rock,	85·76		
	130·00 grains.		

This ore is not worth the expense of mining and separating; but since it was necessary to raise it in sinking that shaft, it will be worth stamping when the mill is not better employed.*

Analysis of a sample of the metal from the silver vein:

Coarse metal from the first jig:

1000 grains yield copper and silver, - - 960
Rock, - - - - - - 40

1000 grains.

Copper sep'd,	922·04 grs.	1844·08 lbs. per ton of metals,	$295 05
Silver "	37·96	75·92 lbs. per ton of metals,	1518 40
	960·00 grs.	Value of one ton metals,	$1813 45

Fine metals from the second jig, (same ore as above:)

1000 grains of the washed metals yield—

Copper,	580·128 grs.	1160·256 lbs. per ton at 16 cts.,	185 63
Silver,	27·872 grs.	55·744 lbs. per ton at $20,	1114 88
Rock,	392·000 grs.		
	1000·000 grains.	Value per ton, -	$1300 51

Fine washed metals from the keive, (same ore as above:)

1000 grains yield—

Copper,	957·796	1929. lbs. per ton—value,	$208 64
Silver,	6·704	13·408 lbs. —value,	268 16
Rock,	35·500		
	1000·000 grains.	Value of one ton, -	$476 80

* The west cross-cut in this shaft is said to have reached the vein, and rich ores are now obtained from it, which I have not yet analyzed.

1000 grains of the waste washings No. 1 analyzed, yielded:

Copper, 200 grains;
Rock, 800 grains.

1000

The metals separated weighed as follows:

Copper, 198 grs. 396 lbs per ton—value, $63 36
Silver, 2 grs. 4 lbs per ton—value, 80 00

$143 36 per ton waste

Waste No. 2. In 1000 grains:

Copper, 120 grains. 240 lbs. per ton—value, $38 40 per ton;
Rock, 880 "

1000

Traces only of silver, not worth separating, were obtained.

Analysis of the average ore from the second shaft, taken by cartloads, from the broken ore, heaped at the mouth of the mine. This ore was stamped in the mill, and the metals were separated by hand jigs by the washers, under my direction. A sample of the fine metals was analyzed, and yielded the following results:

1000 grains of this ore contain—Copper, 919·95
Rock, 73·50
Silver, 6·55

1000·00 grains.

Equal to 1839·9 lbs. copper per ton—value, $294 38
" to 13·1 lbs. silver " " — " 262 00

$556 38 value per ton

of washed metals.

An assay of 20,000 grains of the fine jigged metals from the rotten rock and silver vein yielded 470 grains of pure silver, or 47 lbs. to the ton of washed metals. This was a fair average of the metals of the silver vein.

Operations to ascertain the cost of separating the silver by acids from 1 lb. of the fine jigged metals of the copper and silver vein:

1 lb. avoirdupois of the metals required 2 lbs. 5 oz. of Nitric acid of 40° to dissolve it, the acid being the commercially pure acid of the Roxbury Laboratory. Cost of the acid estimated at 17 cents per lb.

Silver obtained, - - 146·8 = 41·85 lbs. per ton—value, $837
There remained of insoluble rock, 440 grains;
Per oxide iron-scales from the mill, 80 "

520 grains.

A sample of the fine jigged metals from the rotten rock was tried by sulphuric acid, the metal being repeatedly roasted, until the copper was oxidated, while the silver remained bright.

The oxide of copper was then dissolved by the action of boiling diluted sulphuric acid, (oil of vitriol,) sulphate of copper being formed, while most of the silver remained, and was collected at the end of the process. 1 lb. of copper took 2 lbs. of sulphuric acid to convert it into blue vitriol, which, after it was crystallized, weighed 3½ lbs. The rock remained undissolved, the weight of which was 359 grains. The silver obtained was melted and weighed 98 grains; equal to 28 lbs. per ton—value, $560. A portion of the silver was taken up by the sulphuric acid, from which it may be separated by chlorohydric acid; 146 grains of silver should have been obtained.

The cost of acid is from 3 to 4 cents per lb. Before concentration it is much cheaper, and will answer perfectly for parting by this process.

In case you could dispose of the sulphate of copper, or blue vitriol, this process would be the most economical, for it is the usual method pursued in making blue vitriol. The only obstacle would be, that the supply you can produce would soon overstock the market, for there is but a certain quantity required per annum, by the factories, dye-houses, and paint works. So far as you can dispose of your vitriol, this method may be used.* If, however, a continued supply of black oxide of copper is obtained, the manufacturer will prefer that, as he avoids the trouble of roasting the copper; thereby saving his fuel, as the black oxide is in the best state for solution in sulphuric acid.

I have, lastly, to propose a method analogous to the liquation process employed in the Harz mines, in Germany, but differing from that in the following respects. The German ore being a sulphuret of copper and silver, the lead is used in the form of litharge, and the copper remains as scoria, after it has become oxidated, while the lead and silver flow out from the cake of copper ore, and the silver is separated by cupellation. I have modified this process, and tried it with success on a small scale:—

The method is, to use metallic lead, (which will not alloy with

* Mr. Hayes, of the Roxbury Chemical Works, informs me that he will undertake the manufacture of blue vitriol from the metals of the Eagle River mine, and can dispose of all that he can make.

copper, but unites readily with silver,) and then to separate the lead and silver by liquation, and cupel the lead for silver, saving the litharge produced, and using it again after reduction. There is inevitably lost only about 6 per cent. of lead by volatilization, and by sinking into the cupel; so that this is the cheapest process you can employ. In order to operate in the *large way*, you must obtain practical *operatives* from Germany, and a good master of furnaces to direct them, and to keep a vigilant superintendence. In the Harz mountains, at Clausthal, and in several other of the great mining districts of Germany, you can obtain men who will be able to carry on this work; and the best masters of furnaces are the graduates of the school of mines at Freyburg, in Germany.

I beg leave respectfully to suggest, that you should obtain operatives this winter, and have the furnaces erected by them next spring, so that on arrival of a large supply of copper and silver, which you will certainly have next summer, there may be no delay in the separation of the metals, and the melting of your copper into shape for the market.

If you can obtain the Argentiferous lead ores from New Hampshire, Massachusetts, and Maine, they can be advantageously employed in separating the silver from the Lake Superior copper; and you will gain all the silver which exists in the lead ores, also.

The Galena of Shelburn and Eaton, N. H., are rich in silver, and may be obtained. See Report on the Geology of New Hampshire. Several small veins of lead ore also occur in Massachusetts, and may be wrought for the silver which they contain. Near Lubec, Maine, lead ores, containing a small proportion of silver, can be obtained in large quantities.

Some of the lead of the western States contains a little silver; but the metal brought here from Galena and from Mineral Point district does not contain any.

I think there will be no difficulty in liquating silver from copper directly by means of lead ore, the ore being decomposed in the furnace during the operation.

Respectfully,

Your ob't serv't,

CHARLES T. JACKSON.

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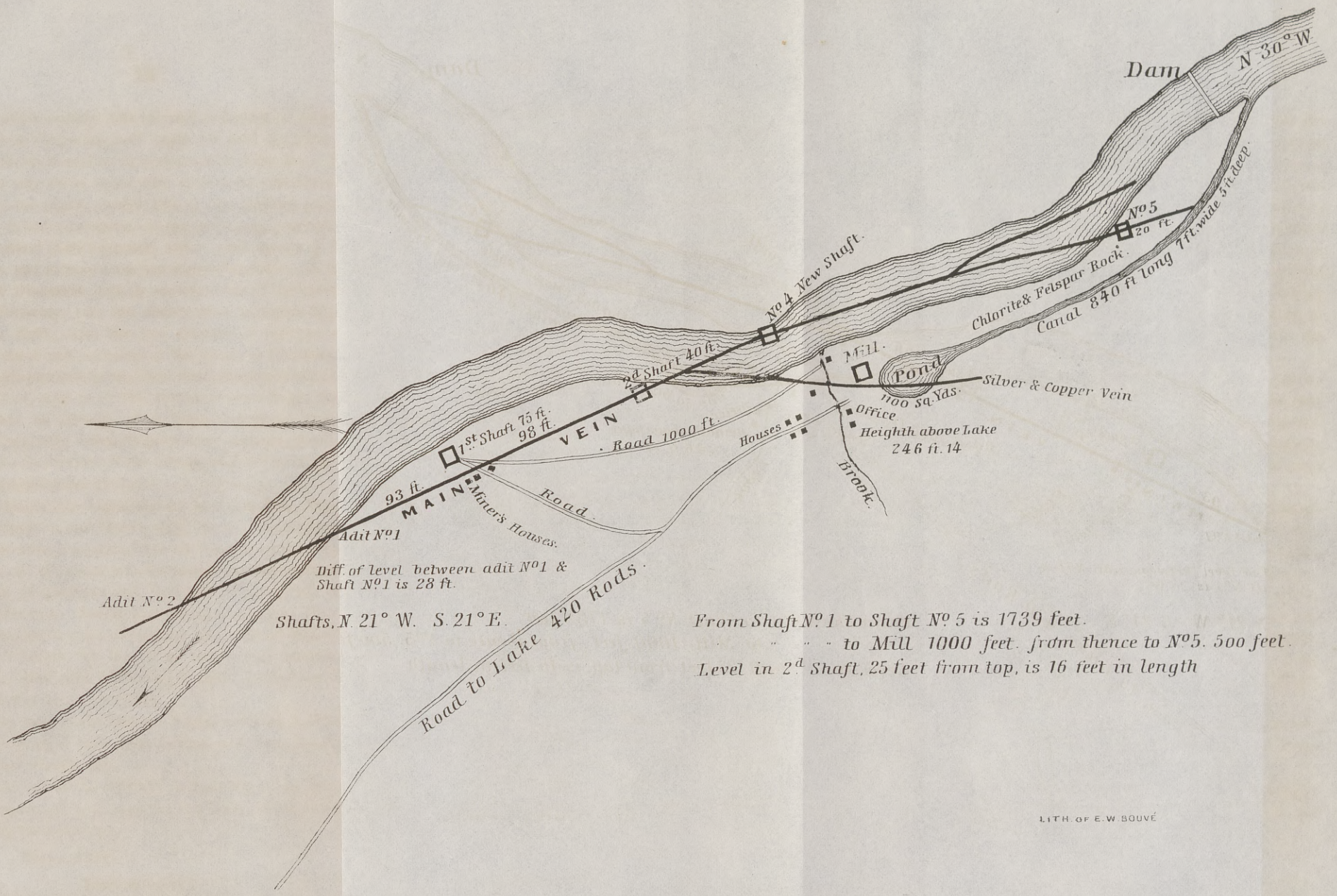
PL. 1.



From Shaft No 1 to Shaft No 5 is 1739 feet.
" " " to Mill 1000 feet. from thence to No 5. 500 feet.
Level in 2d Shaft, 25 feet from top, is 16 feet in length

LITH. OF E.W. BOUVÉ

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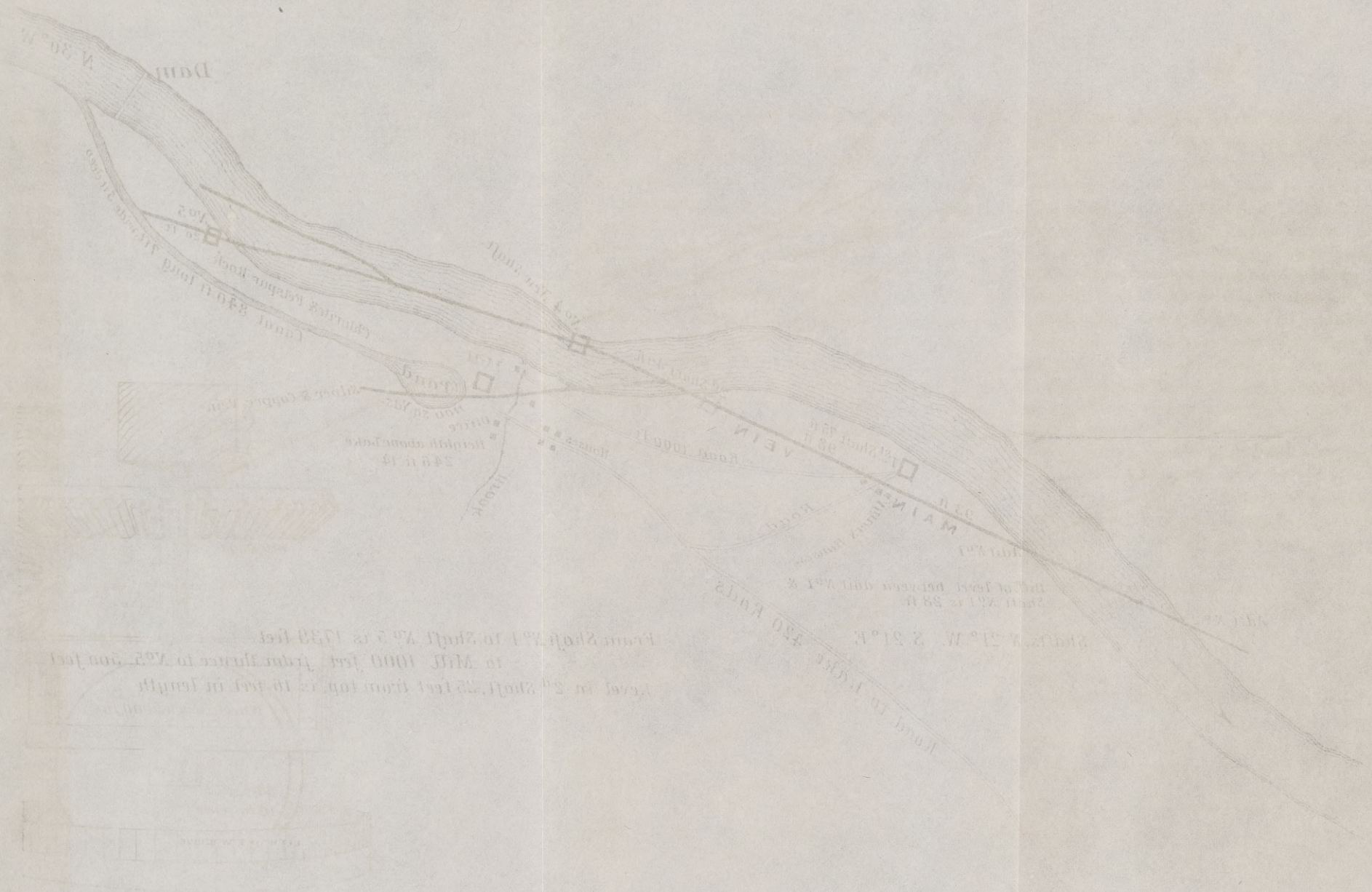
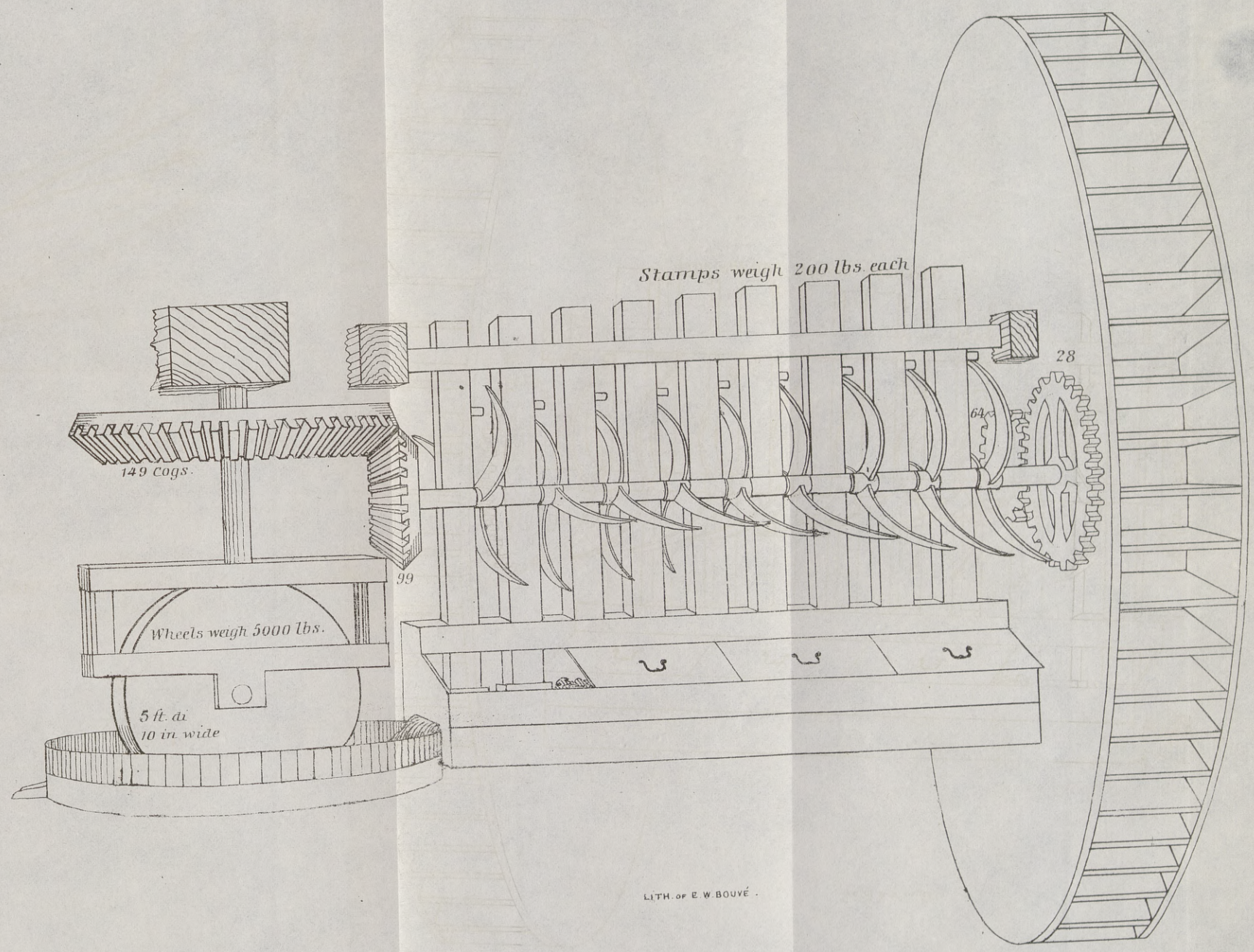


PL. VI



LITH. OF E. W. BOUVÉ.

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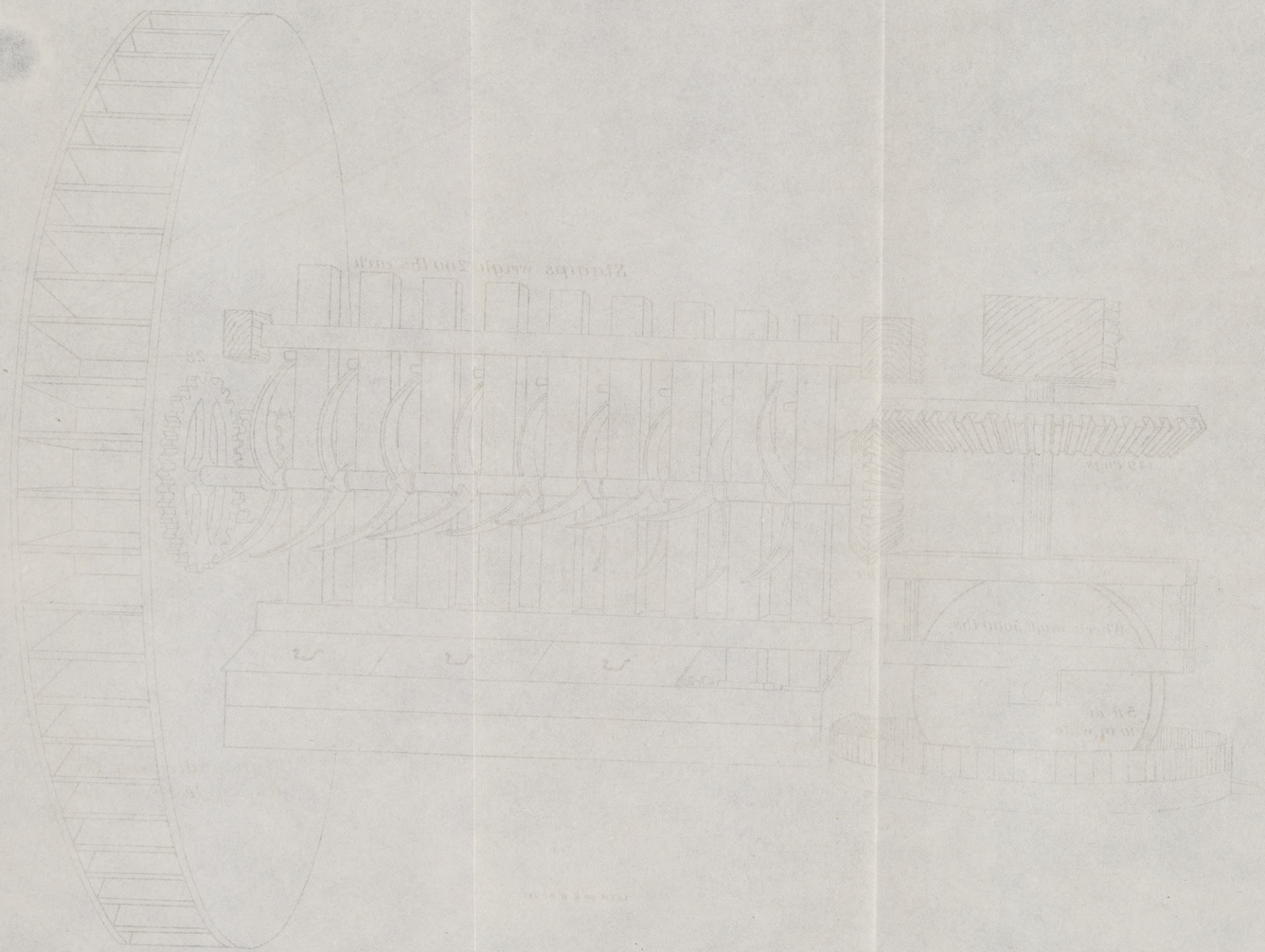
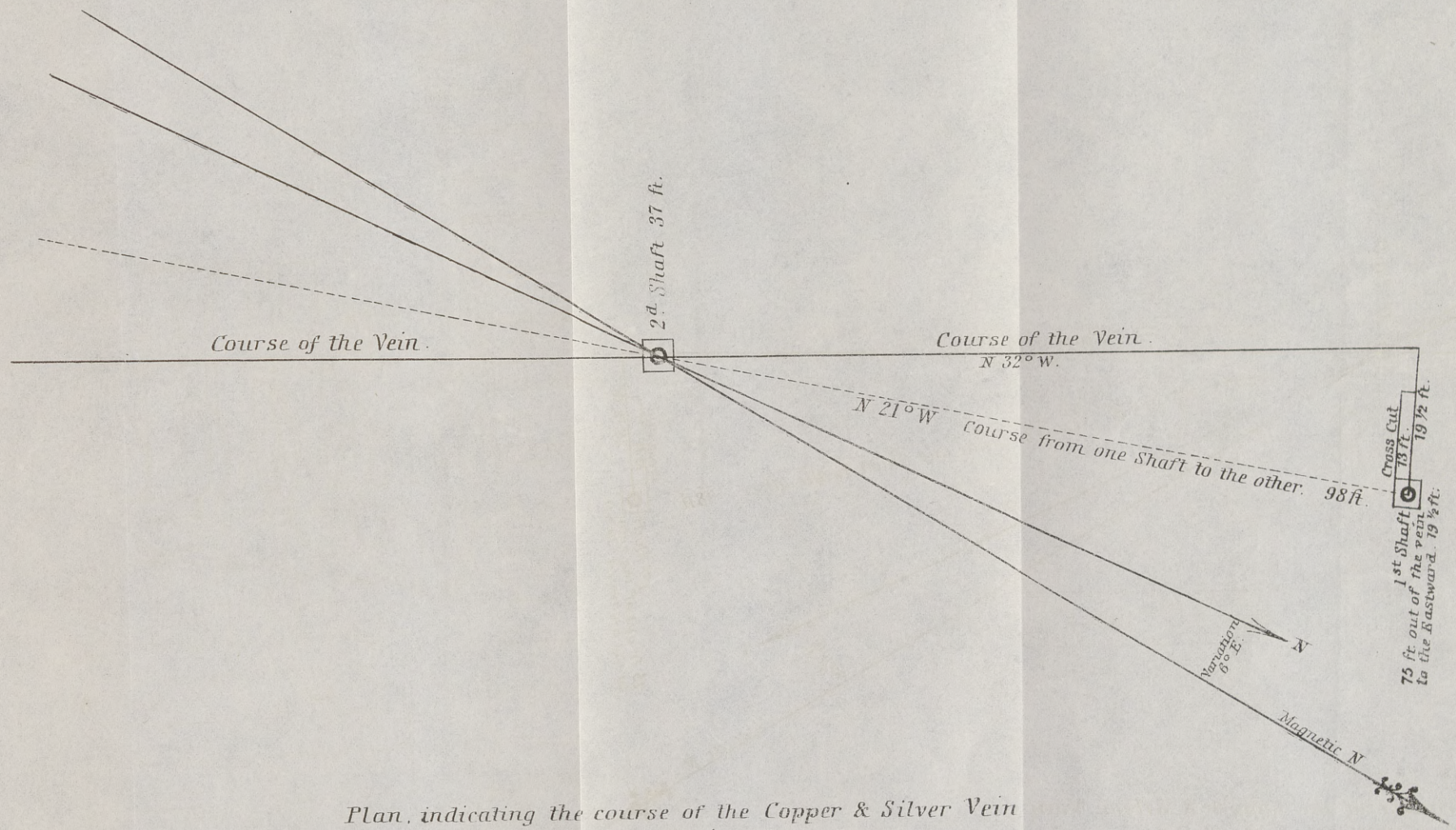


PL. IX.



Plan, indicating the course of the Copper & Silver Vein at Eagle River Keweenaw Point, Lake Superior.

LITH. OF E.W. BOUVE

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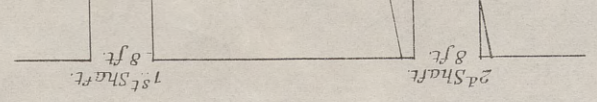
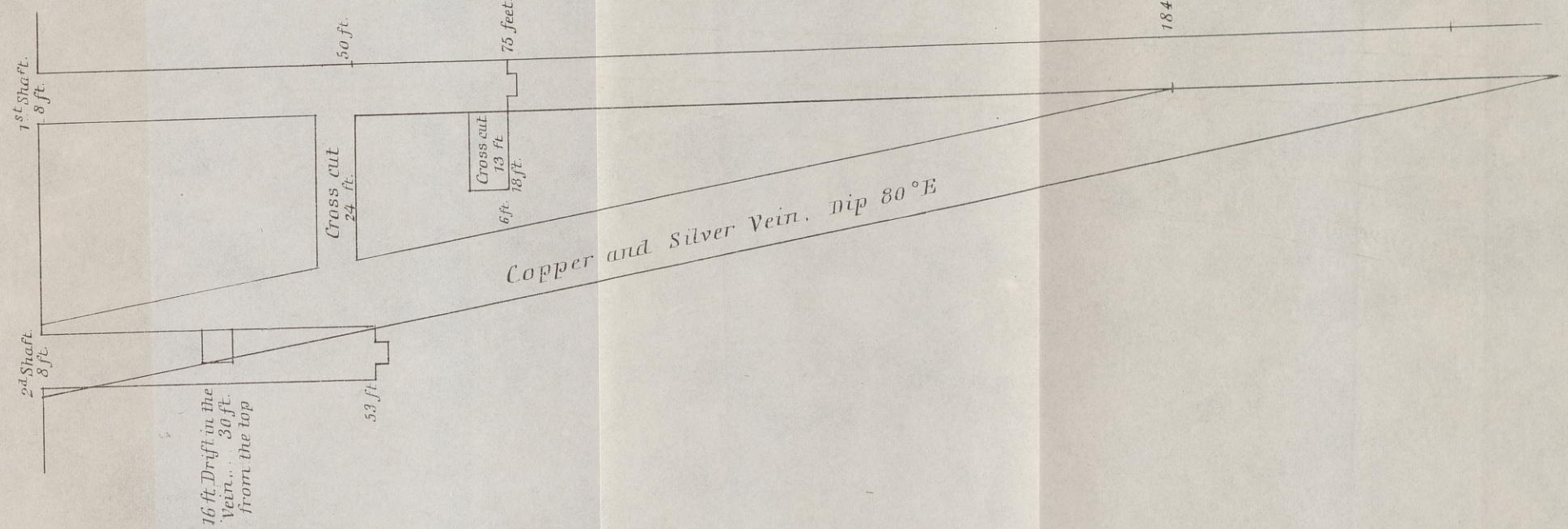

2d Shaft.
8 ft.
1st Shaft.
8 ft.



Plan of the Eagle River Copper and Silver Vein, Surveyed by C. T. Jackson.
Scale, 25th of an inch to a foot.

LITH OF E. W. BOUVE

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